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SCAB AND RHIZOCTONIA

The potato grower cannot afford to produce potatoes severely infected with scab or rhizoctonia. This is especially true in times such as these since, where these diseases are severe, it is questionable if the returns will warrant the investment necessary to plant the crop.

What can be done where scab or rhizoctonia is serious? This must be determined by local conditions. In New Jersey it has been demonstrated that, with but few exceptions, where the acidity of the soil is adjusted to approximately pH 5.2, scab is seldom encountered. The increase in soil acidity is brought about either by the use of sulfur or sulfate of ammonia. While the use of these materials has resulted in a reduction of scab in New Jersey and certain other states it must be pointed out that there are sections where this method has not given equally good results.

In many sections serious losses sometimes follow the planting of seed potatoes infected with rhizoctonia. In some cases these losses result from injury to the sprouts, causing a reduction in yield. In other cases the quality of the crop is greatly impaired. Investigations in New Jersey have demonstrated that the former type of injury is likely to be greatest in seasons when the soil moisture content is low, from the time the seed pieces germinate until the sprouts emerge from the soil. It has been found also that stem lesions increase in severity as the depth of planting increases. Where deep planting is necessary, the practice of shallow covering has resulted in a decrease in the disease.

In the case of both seed-borne scab and rhizoctonia there is ample evidence to show that seed disinfection is well worth while.

The potato grower cannot afford to neglect control measures for these two diseases. The discussion of scab and rhizoctonia in this issue of the JOURNAL should assist the grower in their control.

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THE INFLUENCE OF MAGNESIUM ON DIFFERENT POTATO SOIL TYPES[1]

B. E. BROWN,[2] G. V. C. HOUGHLAND,[2] ORA SMITH,[3] AND R. L. CAROLUS[4]

INTRODUCTION

The importance of magnesium in plant metabolism requires no special discussion. It has been shown repeatedly to be an essential element, without which neither plant nor animal life can exist normally. Magnesium is essential to the development of the normal green color of plants and when lacking, plants become more or less chlorotic. There is, fortunately, no general deficiency of magnesium in soils, for, as a rule, they contain enough for the support of normal plant life. Here and there, however, will be found soils deficient enough in available magnesium to seriously interfere with normal crop production.

Magnesium soil deficiencies have been definitely established by Garner (1) and his co-workers in their studies on tobacco; by Jones (3), working with corn; and by Chucka (5), with the potato. The value of these and other studies have proved that magnesium, while at one time regarded as of secondary importance in relation to plant nutrition, may now be looked upon as a very important plant food element, indispensable to all plant life.

Magnesium is considered to be especially important in the development of seeds, in the assimilation of phosphates, and in the formation of chlorophyl, a function of major importance.

Jones, in his paper dealing with corn, classifies the different types of chlorosis as follows: (1) "Infectious chlorosis, such as the mosaics; (2) hereditary chlorosis, as shown in variegated plants; and (3) nutritional chlorosis, or a failure in the normal development of chlorophyl attributable to a specific nutrient deficiency or toxin." This writer also gives Clinton's (4) definition of chlorosis as: "That unusual state of a green plant in which the chlorophyl, through either diseased or limited development, does not possess its normal bright green color,

[1] Preliminary report covering results obtained in New York and Virginia presented at the American Potato Association meeting in Atlantic City, December 28–30, 1932. Cooperative studies, similar to those in New York and Virginia, also under way in Maine and New Jersey.

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but becomes lighter, yellowish green, or even distinctly yellowish or whitish." It is apparently the latter type that has been found to be fairly prevalent in different potato producing sections in recent years.

OBSERVATIONS MADE COVERING YELLOWING OF POTATO FOLIAGE

During the past 8 or 10 years, particularly in States along the Atlantic Seaboard, frequent reports have been made relative to certain so-called potato "troubles" or as sometimes called "sickness," in which the most conspicuous symptom has been a marked change in color of the foliage, from a normal green to varying shades of yellow. As a general rule, the failure to develop a normal green color was associated with the lowest leaves or when the potato plants were comparatively young. Later foliage would often, however, possess a color more nearly approaching the normal. In addition to the so-called "green-sickness" the plants themselves failed to develop well and remained more or less stunted in their growth.

On Long Island, for example, the attention of the writer was called to a peculiar condition of potato plants in Suffolk County, by Henry R. Talmage. Briefly, there was observed a yellowing of the lowest leaves and a generally stunted growth. Later growth, however, failed to become as chlorotic as the first foliage. The soil on which the trouble first appeared was lighter in texture than the general run of good potato soils in Suffolk County; in fact, came nearer to being sandy loam than loam. As the trouble became more pronounced the soils of better quality became more or less involved.

To some extent a similar condition was observed under New Jersey conditions; although the yellowing was not so pronounced or prevalent as found elsewhere. In New Jersey and on Long Island the trouble was ascribed to excessive soil acidity and to the use of heavy applications of fertilizers, tending to make for even greater soil acidity.

During the summer of 1929 the attention of the writer was called to what was termed a "new potato trouble" in Aroostook County, Maine, which aroused considerable agitation among a number of growers there who felt their yields would be lowered on account of the so-called trouble. Suits for crop damages were threatened and in some cases may have reached trial. The main contention held was that the trouble was due to the fertilizer used. There were some who even maintained that the fertilizer which caused the alleged trouble had been seriously damaged by having gone through a fire while in storage. Analytical evidence, however, tended to show that the injury was not due either to reduced plant food content or to too much or too little of either nitrogen, phosphoric acid or potash.

An official survey made by Messrs. Soule and Thornton of the Maine Department of Agriculture, Dr. Owen of the Maine Agricultural Experiment Station and the writer, covering several days, disclosed that

potato plants in certain fields were affected to the extent of being stunted in growth and possessed a marked yellowing or chlorosis of the lowest leaves. The later foliage failed to attain the normal green color or size associated with healthy potato foliage development. In severe cases dead tissue areas developed and the general effect was a marked reduction in active foliage necessary to starch production. The yields were much curtailed.[5] As both the Irish Cobbler and the Green Mountain, the most widely grown varieties in Aroostook County, were affected it was feared by many that if the trouble became progressively worse the outlook during succeeding seasons might assume serious proportions. An examination of the soil where the trouble occurred showed high soil acidity, sometimes below a pH of 4.5 and quite generally below 5.

In the spring of 1931 reports emanated from the Norfolk and Eastern Shore sections of Virginia concerning a so-called potato "trouble," it being alleged by some that "the potato crop was ruined for that season." The writer made a survey with Dr. Zimmerley, then Horticulturist to the Virginia Truck Station, on June 3 and 4, in an effort to ascertain the nature and extent of the trouble. A large number of potato fields were visited in the two sections, the net result being that in many of them there were observed potato plants over large areas which were abnormal as to size and color of foliage, while in other fields normal vine growth in every respect was the rule.

Two types of injury were observed. In one case, the entire plant was light yellow in color,[6] while in the more prevalent type of injury the lower leaves were more severely involved, with the later growth possessing a more nearly normal color. In the latter type of trouble the plants were stunted in growth and the lower leaves were badly yellowed, the internal structure broken down with brown dead tissue in evidence. This condition was particularly true on sandy slopes subject to light washing. Plants growing in low places possessed a much better appearance with normal color and at the time were blossoming profusely. The affected plants showed little, if any signs of blossoming.

In one field there were found a number of areas which were seriously affected, but where manure or green rye was turned under there was no evidence of the trouble. On another farm where manure was used or alfalfa was plowed under there was no evidence of the trouble.

The most significant factors common to the fields where the trouble was observed on the survey in Virginia were excessive soil acidity and

[5] See article in February-March, 1932, issue of Better Crops with Plant Food, by Jos. A. Chucka, for a detailed description of magnesium deficiency symptoms as evidenced by the potato. This paper also presents experimental results obtained during 1930 and 1931.

[6] The results of foliage tests and the character of the soil indicated this type of trouble was due to lack of available nitrogen.

the use of fertilizers capable of intensifying soil acidity. Tests made on soil samples collected from the fields where the plants were affected showed a high degree of soil-acidity prevailed, some having a pH value as low as 4.2 and practically all fell below pH 5.[7]

Considering briefly all of these highly important potato producing sections, from Maine to Virginia, a certain uniformity of physiological effects was observed. In all sections a chlorosis of the potato foliage, chiefly the lower leaves, was observed; also considerable stunting of growth and reduced yield were common. In many of the potato fields under observation, excessive soil acidity prevailed wherever the trouble was found occurring.

In the use of fertilizer, a ton to the acre being commonly applied for potatoes in the different sections, it was found that the increasing trade tendency to take advantage of the cheapest sources of nitrogen had led to the inclusion of large amounts of ammonium sulphate in the fertilizer mixture, thereby intensifying the acidity of the soil in close proximity to the growing potato plants. Another factor to be considered in connection with that of soil acidity is the undue leaching of basic soil materials, such as lime and magnesia compounds from the surface soil. This would probably become more marked in the case of magnesium compounds, owing to the fact that fairly large amounts of calcium are applied to the soil with the fertilizer.

However, if there continues to be an increasing use of relatively pure salts as fertilizer materials it is likely that both calcium and magnesium compounds will have to be added to fertilizer mixtures. As a matter of fact this is being done at the present time to quite a considerable extent and no doubt the practice will receive increasing consideration as a means of avoiding the development of undue soil acidity as well as furnishing basic compounds required by plants as an insurance against their becoming deficient in soils.

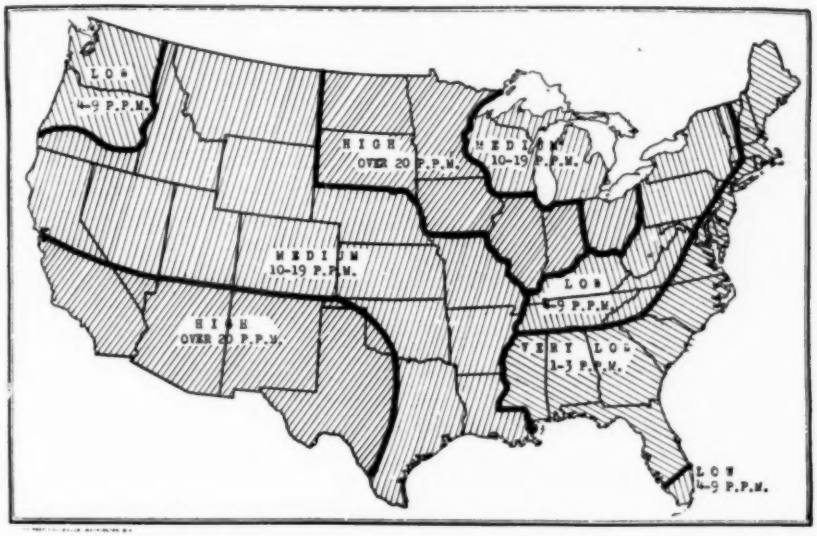
In connection with soil magnesium problems it will be of interest to refer to the chart[8] showing the regional distribution of this element in rivers and lakes in the United States. While, of course, only an approximation of the magnesium present and only indirectly bearing on the soil relationship, the chart serves to show the low content of this element along the Atlantic coastal plain, where light soils subject to heavy leaching prevail.

EXPERIMENTAL STUDIES CONDUCTED IN 1932

In view of the wide-spread chlorotic condition of potato plants prevailing in different sections and to the fact that the Aroostook

[7] Later studies made by R. L. Carolus, of the Virginia Truck Experiment Station, showed that in a number of cases the more prominent trouble occurred also in fields possessing a much less acid soil reaction.

[8] Kindly furnished by Mr. S. B. Detwiler, Bureau of Plant Industry, U. S. Department of Agriculture.



Regional Distribution of MgO in River and Lake Waters. Based on Compilation of Analytical Data from U. S. Geological Survey Professional Paper Number 135.

Charted by S. B. Detwiler, U. S. Department of Agriculture.

County studies showed that under certain soil conditions and fertilizer practices a definite magnesium deficiency existed, it was felt desirable to expand the investigational work with magnesium to other soil types.

Accordingly, during 1932, cooperative field experiments were conducted on prominent soil types in Maine, New York, New Jersey and Virginia to determine the influence of magnesium compounds on the potato, both as to growth relationships and yields. These studies were conducted cooperatively by the Bureau of Chemistry and Soils, through the Division of Soil Fertility, the Maine, New Jersey and New York Cornell Agricultural Experiment Stations and the Virginia Truck Experiment Station.

This progress report deals specifically with the cooperative results obtained in New York and Virginia, while those for Maine and New Jersey will be presented by the cooperators[9] supervising the experimental work in these states.

LONG ISLAND RESULTS

Three cooperative field experiments were established on Sassafras loam with the assistance of County Agent Been to study the influence of magnesium compounds on potatoes when grown in fairly acid soil.

On the farm of John Simon, Peconic, Long Island, a study was made on Sassafras loam to determine the comparative effectiveness of

[9] J. A. Chucka, Maine Station; W. H. Martin, New Jersey Station.

magnesium sulphate, magnesium or dolomitic limestone and high calcium limestone. These three materials were added directly to the fertilizer (4–8–7 analysis) and applied at a rate to furnish approximately a ton and a quarter of the actual 4–8–7 fertilizer to the acre. The fertilizer mixture used was made up on a nitrogen basis, 80 per cent being derived from ammonium sulphate and 20 per cent from dried blood. The treatments were replicated 4 times.

In view of the experiments covering a single season no attempt will be made to present detailed results but rather to express them relatively, putting the 4–8–7 treatment at 100. On this basis an application of magnesium sulphate at the rate of 32.5 pounds of MgO to the acre in addition to the ton and a quarter of 4–8–7 gave a relative yield of 106; magnesium limestone, furnishing 65 pounds of MgO to the acre, 103; and the high calcium limestone, in an amount to furnish the same neutralizing value as the magnesium limestone, gave a relative return of 111, the only result assuming much, if any significance.

In another field comparison on the Simon farm, a 4–8–7 fertilizer was used with only 40 per cent of the nitrogen derived from ammonium sulphate; 40 per cent from sodium nitrate and 20 per cent from dried blood. The fertilizer gave a yield of 100 expressed relatively, the addition of magnesium sulphate raising this to 106. The soil acidity of these fields was reported as high, the pH value being about 4.2.

Two additional tests were made comparing 4–8–7 alone with the fertilizer plus magnesium sulphate. These trials were conducted on the farms of Fred Zeh, Calverton, and W. W. Bishop, Southampton, Long Island. On the Zeh farm the effect of the magnesium compound was to increase the acre yield 10 bushels. The soil of this field had a pH of 5.2.

On the Bishop farm practically identical yields were obtained, a difference of only 0.5 bushel in favor of the magnesium treatment resulting. The soil in this test had a pH value of 4.9.

RESULTS OF MAGNESIUM STUDIES IN VIRGINIA

Three magnesium field experiments were started in the Tidewater section of Virginia, two in the Norfolk section, on Norfolk sandy loam, the third on the Eastern Shore, near Cape Charles, Virginia, on Sassafras sandy loam.

One test in the Norfolk section was made on the farm of H. D. Williams in a field where considerable yellowing of the potato foliage was noted in 1931. The plan was to treat a number of rows with 7–8–5 fertilizer alone, at the rate of a ton to the acre, and the same number of rows with the same quantity fertilizer plus magnesium sulphate to furnish 25 pounds of MgO to the acre. The soil where the test was located possessed an average pH value of about 4.2, showing a relatively high degree of soil acidity. The fertilizer used contained .055

per cent of magnesium (Mg) and of the 7 per cent ammonia content, 4.88 was present as ammoniacal nitrogen, 0.12 per cent as nitrate nitrogen and the balance from other sources, chiefly organic.

Plant analyses of representative foliage samples from the magnesium treated potatoes and from those untreated gave results showing from two to three times as great an intake of magnesium on the magnesium treated plants.

The yields obtained in this particular test were much better where magnesium sulphate was applied, the average increase being about 48 bushels to the acre over the fertilizer alone.

On the T. E. Carney farm, however, where the pH reading on the soil was 5.5, the average increase was only about 4 bushels to the acre in favor of the magnesium treated rows.

On the Eastern Shore a magnesium experiment of greater scope was laid out on the farm of C. S. Willis and Bros., near Cape Charles. Considerable injury was observed on this farm in 1931, as evidenced on the survey that season. In this experiment comparisons were made of different fertilizers, one high in ammonium sulphate, and another containing less of this material and more sodium nitrate, with and without the addition of magnesium sulphate and magnesium limestone. In order to check against the neutralizing value of the dolomitic material a high calcium limestone treatment was included. Every magnesium or lime treatment was paired with a fertilizer treatment alone in order to provide direct comparisons. However, it was disclosed that this field had received an application of magnesium limestone which appeared to be sufficient not only to prevent a recurrence of the chlorotic symptoms but also to preclude significant yield differences.

ANALYTICAL STUDIES ON POTATO FOLIAGE

During the course of the 1931 survey of potato fields a number of foliage samples were collected and subjected to chemical analysis for calcium and magnesium. The results are given in the accompanying table.

From an examination of the results presented in Table 1, it will be readily noted that some relation exists between the condition of the potato plants and the intake of magnesium. The foliage samples were collected during the 1931 crop season when a considerable amount of chlorosis was in evidence on farms where no magnesium had been applied, the analytical differences arising solely from natural growth differences on the same farm. One field would show the trouble while another would not. It is clear that there is a significant difference in the magnesium content of healthy and injured potato foliage. The average content of magnesium in healthy tissue is .21 per cent; in abnormal, only .095 per cent.

TABLE 1.—*Effect of yellowing on calcium and magnesium content of potato plants in Virginia*

Sample number	Date of sampling	Farm location	Part of plant	Plant condition*	Ca	Mg
					%	%
1	5/14/31	J. L. Wilroy	Leaves and stems	Healthy	1.05	0.22
2	"	"	" "	"	0.96	0.20
3	"	"	" "	Injured	0.38	0.11
4	"	"	" "	"	0.35	0.10
5	"	H. P. Harrell	" "	"	0.45	0.11
6	"	"	" "	"	0.50	0.11
7	"	"	" "	Healthy	0.82	0.16
8	"	"	" "	"	0.69	0.17
9	9/29/31	T. E. Carney	" "	"	1.20	0.25
10	"	"	" "	Injured	1.17	0.13
11	"	R. L. Odom	Lower leaves	"	1.00	0.08
12	"	"	" "	Fair	1.29	0.12
13	"	Ivins & Green	" "	Injured	1.61	0.09
14	"	"	" "	Healthy	1.80	0.19
15	6/6/31	H. P. Harrell	" "	"	1.62	0.19
16	"	"	" "	Injured	1.26	0.08
17	"	J. L. Wilroy	Upper leaves	Healthy	0.96	0.24
18	"	"	Lower "	Injured	0.86	0.07

* Healthy—Plants in a good vigorous growing condition.
Injured—Plants showing yellowing and stunting.
Analyses made by Soil Fertility Investigations, Bureau of Chemistry and Soils.
Foliage samples collected by R. L. Carolus, of the Virginia Truck Experiment Station, who is making a detailed study of the problem. Permission to use these data kindly granted by Mr. Carolus. Not all of the fields, according to him, possessed a marked acid reaction, some being close to or beyond neutral point.

It was also found that an application of magnesium sulphate made some time after the plants became affected was absorbed to a considerable extent, about twice as much magnesium being present as in the untreated plants. Again, in the controlled 1932 test on the Williams farm is was found that the plants grown on the magnesium treated rows contained well over twice as much magnesium as the plants grown on the rows which received the fertilizer alone.

SUMMARY

Observations made over a period of several years have disclosed well defined growth disturbances of potato plants in a number of important potato producing sections. The sections under observation have been chiefly along the Atlantic seaboard, including certain potato producing sections in Maine, New York, New Jersey and Virginia, although reports of similar plant disturbances have been reported elsewhere.

Wherever the trouble prevailed the chief symptom has been a chlorotic condition of the foliage, the lowest leaves being most seriously affected. In severe cases these leaves finally turn brown, thicken, become hard and eventually die. The change of color from normal green

to yellowish green to yellow starts at the margin of the leaf and gradually involves the entire leaf until in advanced stages brown necrotic areas develop.

The plants were stunted in growth and while frequently the later growth possessed a more nearly normal color there would be enough of an upset in the life of the plants to cause marked reductions in yield.

In practically every case examined, the main exceptions occurring in Virginia, the affected plants were found to be growing on very acid soil, pH 4.2 to 5.0, probably too acid for normal potato development. Coupled with this was the use of fertilizer containing a high proportion of ammonia nitrogen which tended to aggravate the acidity prevailing near the growing plants. With this high acidity factor prevailing it would be reasonable to assume that leaching of basic compounds would be active, particularly lime and magnesia. Where the pH reading went much above 5.2 very little, if any, trouble was in evidence, nor was it found where considerable quantities of manure were used or green cover crops turned under.

As there were no recognizable pathological symptoms it was believed that the chief trouble was an improper nutrition of the plants, due to some deficiency of an essential element or possibly to the presence of some poisonous compound in the fertilizer. However, analytical work on samples of fertilizer which were applied for the potato crop showed no toxic material present and in every respect the fertilizer was normal so far as plant food content was concerned. About the only special feature brought out by the work was the large proportion of ammonia nitrogen in the fertilizer.

In all of the sections under observation, the common fertilizer practice followed is to use at least 2000 pounds of high-grade fertilizer to the acre, ordinarily applying the plant food material close to the potato seed pieces. It is obvious that any tendency of the fertilizer ingredients to increase soil acidity would be highly localized.

As a result of field studies started in Aroostook County, Maine, in 1930, it was clearly shown that the trouble was due to a deficiency of magnesium in the soil brought about by excessive acidity and the use of fertilizer materials carrying less impurities, including magnesium.

In order to obtain readings on other soil types, cooperative field studies were started in 1932 on Sassafras loam on Long Island, on Sassafras loam in New Jersey, and on Norfolk sandy loam and Sassafras sandy loam in Virginia. The results presented herein cover the cooperative magnesium studies conducted on Long Island and in Virginia, reports of the work in Maine and New Jersey being presented separately.

On Long Island, based on one year's results, no marked differences were obtained through the use of magnesium and lime compounds. Of

the two elements, calcium and magnesium, the former was the more effective in promoting better plant development and higher yields, indicating that reducing soil acidity to a point more favorable for the potato is desirable. The practice of making light applications of lime to lower the acidity has been followed for some time on Long Island and New Jersey.

In Virginia, on Norfolk sandy loam having a pH of 4.2, the effect of adding magnesium sulphate to the fertilizer proved highly beneficial. The increased yield due to the magnesium treatment was about 48 bushels to the acre, a very significant increase. On another farm where the same soil type was utilized for the magnesium experiment no significant differences in yield were obtained. The soil in this test ad a pH reading of 5.5. The result of this test proved to be in harmony with that of other experimental work, namely, that soils possessing a pH around 5.5 are not in such great need of magnesium application as those with low pH values, around 4.5 for example.

In a magnesium experiment on Sassafras sandy loam conducted in 1932 in the vicinity of Cape Charles, Virginia, application of different magnesium compounds and lime carbonate failed to give significant differences in yield.

A chemical analysis was made of potato foliage samples collected on farms where the chlorotic appearance was very marked and of samples from other fields on the same farm where there was no trouble observable. The data showed clearly that the intake of magnesium was considerably less where the chlorosis prevailed. Apparently, when the magnesium content of potato plants drops below .15 per cent trouble may be expected. When the magnesium content dropped as low as .1 per cent, and lower, noticeable injury to the potato plants was in evidence.

An interesting point connected with the chlorotic appearance of potato plants, high soil acidity and consequent leaching of basic soil compounds is brought out in studying the magnesium content of streams, both major and minor, and lakes, over wide stretches of the United States, as published by the U. S. Geological Survey. Along the Atlantic Seaboard, in the Coastal Plains Section where the soils tend to leach readily, the amount of magnesium in the water sources is much less than in other sections of the country. This suggestion serves to show that the sections where magnesium is shown to be comparatively low in streams are where magnesium soil deficiencies have been found to be most prevalent.

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POTATO SCAB AND RHIZOCTONIA AND THEIR CONTROL

MAINE

The 1932 seed-potato treatment experiments on Aroostook Farm, Presque Isle, Maine, again indicate that, when Rhizoctonia-infected seed is planted, a significant increase in yield may be expected as a result of treatment. The increases in yield this year ranged up to about 17 barrels per acre.

The standard corrosive sublimate treatment and the acid corrosive sublimate treatment (4 ounces corrosive sublimate to 15 gallons of water, plus one per cent commercial hydrochloric acid used as a 3 minute soak) were among the best treatments used. The organic mercury dips were slightly inferior in control of Rhizoctonia this year.

Irish Cobblers that have been grown on Aroostook Farm for five seasons and selected as free from Rhizoctonia showed only a trace of Rhizoctonia even in the untreated lot.—W. P. RALEIGH and REINER BONDE.

In Aroostook County we have recommended the use of mercuric chloride for disinfecting seed potatoes for the past twelve years. We have suggested that the potatoes be soaked for from thirty to ninety minutes. In most cases, however, the growers have adopted the hour treatment.

In the past few years we have suggested to our growers that either the Improved Semesan Bel or Sanoseed can be expected to give good results and a number have used these materials since less time is required for the treatment. Several of our larger growers have tanks in which they set the hopper of a Boggs grader. In this way they can disinfect 40 to 60 barrels an hour.

We recommend that all Irish Cobbler seed potatoes be disinfected since the results of tests conducted by the Maine Experiment Station indicate that in addition to controlling Rhizoctonia, the crop from treated seed has fewer sclerotial bodies than where untreated seed is planted. In view of financial conditions and insufficient data our recommendations in the case of the Green Mountain variety are not so general. We do, however, recommend that the seed be disinfected where there is much rhizoctonia present.—VERNE C. BEVERLY.

NEBRASKA

Under Nebraska conditions the only satisfactory treatment for potato scab is the hot formaldehyde method; this, however, is not so satisfactory for rhizoctonia as the mercury treatment. As a result I recommend hot formaldehyde in the western part of the state where scab is of great importance. In eastern and south central Nebraska, where rhizoctonia is more important, often being followed by blackleg, I recommend the use of mercury treatments. Last year a number of the larger growers used the New Improved Semesan Bel. They were well satisfied with the results and I believe will continue to use this material in the future.—R. W. Goss.

NEW YORK

In New York State soil-borne scab is a serious problem in the high limestone sections up-state. Experiments have been conducted during the past two years in an effort to determine a satisfactory control measure.

The addition of mercurial compounds to the soil mixed with the fertilizer has increased markedly the percentage of scabbed tubers in the crop. Calomel at rates up to 20 pounds per acre appears to be slightly worse than yellow oxide of mercury at 10 pounds. Organic mercury compounds while causing more scab than the checks have not been so stimulative as calomel or yellow oxide. Aluminum sulfate, while reducing scab, has given marked yield reduction as compared with the checks. These results have been consistent for two years in these experiments.

Mercurial seed treatments have been found to increase rather than decrease the amount of scab. Again calomel has given the most increase with yellow oxide, mercuric chloride, and organic mercury compounds following in order. Formaldehyde treatments on the other hand generally show a slight reduction in scab as compared with the untreated. However, the greatest yield increases have been obtained with the mercury treatments in approximately the order of their effectiveness in increasing scab on the crop.

The broadcasting of sulfur has been tried in a number of fields. Inoculated, wettable and untreated sulfur of different grades of fineness have been used. Rates of application have been studied in several cases. In general the increase in acidity as measured by the pH scale has not been great as had been reported from areas with soils of lighter types. As might be expected increase in acidity and decrease in scab varies from field to field, depending on the buffer action of the different soils.

In all cases where compared, inoculated sulfur has been no more effective than commercial flour sulfur of equal fineness. Finely

ground dusting sulfur and particularly dusting sulfur to which a wetting agent has been added have been slightly more effective than the coarser sulfurs.

Sulfur applied in the fall or in the spring before plowing has given no control in the first year. Best results were obtained by applying the sulfur broadcast in the spring after the ground has been partially fitted. The sulfur is then harrowed in and mixed through the top few inches of the soil.

The use of sulfate of ammonia rather than nitrate of soda as a nitrogen source in mixed fertilizers has given reduced percentages of scab on the crop. This reduction is dependent on the amount of sulfate used and is not recommended as the only measure where scab is severe but as a practice which will slightly reduce the injury.—C. F. TAYLOR, New York Agr. Exp. Sta.

In New York disinfecting seed potatoes with mercury compounds the past four years have given variable increases in yields. This should probably be expected due to variations in the weather at planting time and the infestation of rhizoctonia. Thus the average increases for this period for mercuric chloride (249 comparisons), yellow oxide of mercury (328 comparisons) and calomel (178 comparisons) have been 10.3, 11.3 and 9.7 bushels per acre respectively over the untreated. These increases, though not large, are all apparently significant. Semesan Bel has apparently given increases in some fields but the average of 84 comparisons is not significantly different from the untreated. In comparisons for the past two years cold formaldehyde (18 comparisons) has given barely significant increases in yield while hot formaldehyde (46 comparisons) has not.

Inorganic mercury compounds have given the greatest reduction in percentage of tubers bearing sclerotia of rhizoctonia. Organic mercury compounds as Semesan Bel and Corona P. D. 7 and formaldehyde treatments have given only slight reductions. Seed treatment has had a significant effect on how quickly the seed pieces rot, although it may not always be desirable to have this rotting delayed. At a time when the plants were only a few inches high there was an average of 39 out of 100 fewer rotted seed pieces on the yellow oxide treated than on the untreated. The corresponding figures for mercuric chloride and calomel treatments were 12 and 14 respectively.

In those areas of the state where soil-borne scab is an important factor it has been found that treatment with mercurial compounds, particularly the inorganic mercurials, increases scab on the crop to a significant extent. Thus during the past two years in the high limestone areas hot mercuric chloride treatment has shown a significant increase in scabby tubers of 8.0%, yellow oxide of 8.3%, Semesan of 1.5% and cold mercuric chloride of 1.2%. The last three differences

are not significant. Cold formalin has shown a reduction in scab of 9.1% and hot formalin of 3.8% as compared with the untreated.

From the available data the recommendations are to use mercurial treatments in districts where the soil is so acid that scab is not a factor. Yellow oxide of mercury, 1 pound to 15 gallons of water, is a satisfactory treatment but experience has indicated that it is advisable to treat shortly before planting. Hot mercuric chloride is effective and is widely used as a cooperative treatment under Farm Bureau supervision in New York State. In districts where soil-borne scab is severe formaldehyde treatments are to be preferred—C. F. TAYLOR and L. L. STIRLAND, New York Agr. Exp. Sta.

OHIO

Common scab of potatoes, caused by *Actinomyces scabies,* is prevalent throughout Ohio. There is no particular section of the state where scab is naturally more severe than in any other section. Western Ohio is known to be a limestone area and the northern part of this district is an important potato producing section. Scab might be expected to predominate in this part of the state, but as a matter of fact it is no more prevalent there than in northeastern Ohio. The latter area is the more important potato district from a production standpoint, and scab seems to be on the increase in this section. Intensive farming and a naturally acid soil has led to the use of large amounts of lime, and whenever sufficient lime is used to bring the soil reaction to near the neutral point, scab usually appears. It is rapidly becoming impossible to grow a clean crop of potatoes in certain fields which have been limed heavily in this district. Many fields are now at the stage where they produce a crop with considerable scab in extremely dry years.

The scab gnat, *Pnyxia scabiei,* has made the scab problem more serious and complicated in Ohio. The larvae of this insect inhabit and eat out the scab lesions on the tubers, leaving shallow pits instead of the corky, raised areas characteristic of scab. Scabby potatoes are always objectionable, but they are immensely more desirable from the consumer's standpoint than tubers injured by scab gnats. Recent investigations of this Station have shown that while the scab gnat may occasionally attack clean tubers, most of the injury occurs where scab is prevalent, and that all practices which tend to reduce scab, such as seed treatment and acidifying the soil, also reduce the scab gnat injury.

Long rotations have been of little or no value in eliminating the scab organism from the soil after it has once become established. As long as the soil reaction remains favorable for the scab organism the disease occurs regardless of what rotation is used or how long the interval is between potato crops. There is some evidence that the

organism occurs naturally in some sections of Ohio. Instances are known of where land has not been cultivated for 40 years and where potatoes were never grown as far as any one knows, but on which a scabby crop was obtained when the land was finally plowed and planted to potatoes.

Some progress has been made in Ohio in controlling scab by the application of sulfur to the soil. This practice has not met with as much favor, however, as it has in the east. The reaction of our heavier soil types is more difficult to change by light applications of sulfur than is that of light, sandy soils. It is necessary to apply considerably over 500 pounds of sulfur to the acre to lower the reaction of some of our soils to the point where scab will not occur. Work is now under way in the soils division of this Station to determine the rate of application of sulfur necessary on the various soil types to lower the reaction sufficiently to eliminate scab. Another complication is that a great many of our potato growers are also dairymen and wish to grow a legume forage crop in the rotation. Because of this they have been rather reluctant to apply much sulfur to the soil, since when the soil is acidified to eliminate scab, it is difficult to grow legumes.

The intelligent and restricted use of lime on the soil, the plowing under of a green manure crop preceding potatoes, the use of ammonium sulfate as the nitrogen carrier in the fertilizer, the application of sulfur to fields in which a profitable crop of clean potatoes cannot be grown, and the planting of scab-free or treated seed, are the practices recommended in this state for the control of scab. Growers are beginning to realize that excessive liming invites potato scab, and have curbed, to some extent, the application of large amounts of lime to fields in potato rotations. So far, our scab problem among potato growers has not been serious as it has been in certain other sections. It is bad enough, however, to make us question the advisability of growing potatoes on land which has been limed sufficiently so that a good crop of sweet clover or other lime loving legumes can be grown. —Paul E. Tilford, Ohio Agr. Exp. Sta.

WISCONSIN

Soil reaction, soil moisture, and soil temperature are among the chief factors which influence the occurrence and development of potato scab. Fluctuations in any of these factors will influence the severity of scab one way or another in the different seasons. With the object of gaining more knowledge of these factors in relation to scab, a study of potato scab was made both under greenhouse and Wisconsin field conditions during the past two years.

In the summer of 1931, and again in 1932, a field survey was made of a number of potato fields in the Antigo and Rhinelander potato

growing sections. Soil samples were taken in different parts of one and the same field, showing variations in the percentage and severity of scab, and their acidity (soil reaction) determined. All samples were taken just after digging and while the potatoes were still on the ground. In both years a definite correlation was found to exist between the soil acidity and scab, the higher percentage of scab in one part of the field always being correlated with a higher soil reaction or lower acidity as compared with that from another part of the same field. In general very little scab and unsaleable tubers were produced in soils with an acidity testing pH 5.3 or lower. At pH 5.4 to 5.5 scab was somewhat more severe while very high percentages and severe scab were always associated with soil reactions above pH 5.5. Some fields that had been cropped to potatoes for three years or more, sometimes for three years in succession, and that had a soil reaction of pH 5.3, showed less than one per cent scab. In greenhouse experiments it was found that where the soil reaction of a naturally and heavily infested soil was changed from pH 5.8 to pH 5.17 and lower before the tubers had set, by the addition of sulphur, scab was controlled.

Field trials with sulphur, ammonium sulphate, and aluminum sulphate for the control of scab, at four widely separated points in Wisconsin, gave no control during the summer of 1932. Sulphur at the rate of 300, 600, and 900 lbs. per acre, 120, 240 and 360 lbs. of ammonium sulphate per acre, and 360, 720 and 1080 lbs. of aluminum sulphate per acre were applied as a side-dressing on both sides of the rows just after planting. None of these applications apparently changed the soil reaction to a degree of acidity unfavorable for scab. Determinations of the soil reaction showed that only in the case of sulphur was the soil reaction, in some cases, changed to pH 5.0 or lower. This acidity was apparently not reached until after the tuber had set. The unusually hot and dry summer of 1932 in Wisconsin might have been partly responsible for the failure to secure scab control with any of these chemicals. Soil treatment with sulphur under certain climatic conditions apparently has to be made in advance of planting if favorable results are to be expected.

From greenhouse experiments some evidence was obtained that would indicate that an unfavorable soil reaction is more effective at temperatures above or below the optimum temperature for scab development.

The effect of soil moisture on potato scab as studied under greenhouse conditions was found to be very marked. Potatoes grown in uniformly inoculated, and also in naturally infested soils, at different temperatures, showed very marked decreases in scab with increased soil moisture, even at a temperature most favorable for scab development. Increased soil moisture while reducing scab, at the same time

increased the yield in all of these experiments. The following table shows the effect of soil moisture on scab in a naturally infested peat soil with a water holding capacity of 288 per cent.

Soil moisture water holding capacity	Weight of tubers	Surface scabbed	Total number of lesions	Average no. of lesions per tuber
per cent	*grams*	*per cent*		
40	160	25	987	62
55	234.6	4	292	36
70	205.9	less than 1	93	8
85	214.4	less than 1	75	7.5

In another experiment the influence of soil moisture on scab at different stages of tuber development was studied. The results indicated that soil moisture is of greater importance during the latter part of the growing season than in the early stages of tuber development and that soil moisture will control scab even after the tubers have become infected, provided the tubers have not yet reached their full stage of development.

The results of the experiments during the past two years would indicate that applications of sulphur at the rate of 300 to 900 lbs. per acre under certain conditions will change the soil reaction to a degree sufficient to control scab. A thorough distribution of the sulphur through the upper four inches of soil some time in advance of planting is suggested. Cultured practices that would conserve more soil moisture might have a beneficial effect on scab control. It is also evident that better results in the control of scab might be expected where potatoes are grown under irrigation if a liberal application of water could be maintained for some time, especially during the latter part of the growing season.—B. J. DIPPENAAR, University of Wisconsin.

Potato seed disinfection for scab and Rhizoctonia control is a recognized standard practice among the Wisconsin certified seed growers and is widely but not universally done by growers of table stock. The different methods of treatment include cold and hot formaldehyde, cold corrosive sublimate, acid mercury dip, Semesan Bel and Corona PD 7. They have all been used with varying degrees of satisfaction and each has its advocates.

The use of cold formaldehyde, one pound to thirty gallons water, soaking for two hours, is practically confined to isolated growers who do not have money to invest in corrosive sublimate or who are afraid

of its poisonous nature. It is fairly efficient in the control of scab but has only a moderate control of Rhizoctonia under Wisconsin conditions. Hot formaldehyde, as devised by Melhus, has been demonstrated and tried extensively. This treatment has given excellent control of scab and Rhizoctonia, but its use has been followed by greatly reduced germination with consequent reduced yields.

Greatest reliance is still placed on the corrosive sublimate treatment since it controls the scab and Rhizoctonia infection on the seed and is not excessive in cost. An objection to corrosive sublimate is the time required for the treatment. The acid mercury dip has been making marked gains in popularity during the past two seasons. This is primarily based on the speed of operation. The 5 to 10 minutes in the acid mercury dip seems almost nothing in comparison to the one and one-half hours of the corrosive sublimate treatment. The speed of operation also allows for treating in more favorable weather for drying the seed. With growers of 50 acres or more this is quite a factor for consideration. In a few cases there has been some injury to germination from the acid mercury dip where the tubers were sprouted too much at time of treating or where they were not properly dried. In the control of Rhizoctonia in 1932 in Langlade County, Wisconsin, acid mercury, 10 minutes, gave 97 per cent clean tubers; 5 minutes, 82 per cent; corrosive sublimate, 1½ hours, 52 per cent; cold formaldehyde, 36 per cent and no treatment, 16 per cent. With the same treatments the per cent of severe Rhizoctonia on the tubers was 1, 3, 23, 34 and 36 per cent respectively. The stem lesions were of small account in any of the treatments in the experiment. In some untreated fields the reduction in stand from Rhizoctonia may be considerable.

Semesan Bel and Corona PD 7 have given such variable results that no recommendation can be made based on experimental work. A few growers have been sufficiently well pleased with these and other new treating compounds that they will continue to use them if the prices can be reduced to the range of possibility. The short dip required is the factor that appeals to the average potato grower.

With the scab and Rhizoctonia diseases in Wisconsin, one of the greatest factors to be considered is the amount of soil infection that is widespread in all the older potato growing sections. This factor is so commanding in some places that seed disinfection is being reduced because no results can be seen from the labor and material expended. In all such cases we are recommending a farm survey in order that heavily infested soils may be avoided in planning the location of potato fields. There is enough good potato soil on most farms so that it is not necessary to grow potatoes on the infected soil when its location is recognized.

It is considered that the amount of scab on the crop is dependent also on the conditions of moisture and temperature in the soil at the time the tubers are forming. In further study of these conditions we have a project under way in connection with our Rice Lake, Barron County, demonstration farm. One acre on which scabby Triumphs were raised in 1932 will again be planted to Triumphs this season, one third on each of three dates, about May 1, May 25, and June 15. The seed used in this project will be clean seed treated with corrosive sublimate.—R. E. VAUGHAN, University of Wisconsin.

CROP AND MARKET NEWS

POTATO ACREAGE REDUCED

The March report on planting intentions of growers showed some changes from the earlier reports. Total United States acreage of potatoes for harvest this year is now expected to be 3,185,000 acres, or fully 5% less than the harvested potato area of 1932. Early shipping States report a decrease of about 2% and the intermediate States a reduction of around 4%. These decreases are expected to occur chiefly in the commercial shipping acreage, while plantings for local needs and for home use may be maintained or increased.

Among the late shipping States, growers' reports give evidence of largest reductions in the commercial potato areas at greatest distance from the market. The net decrease for the 18 surplus-producing late potato States is indicated as 8%, while the 12 other late States show a probable increase of 4% over last year's acreage.

This would indicate total plantings for harvesting this year very similar to the 1930 acreage. However, the average United States yield of about 106 bushels per acre in 1932 was approximately 10% below normal and 5% lower than that of 1931. Assuming more favorable growing conditions and higher yields this year than last season, the total crop might easily equal (if not exceed) the 1932 production of 356,589,000 bushels, in spite of reduced plantings.

With reference to that portion of the potato crop which is grown primarily for shipment to market, commercial acreage in the second group of early States may be 18% below that of last season. The four second-early States together show a probable reduction of 3%; the first group of five intermediate States a prospective cut of 14% below the acreage harvested in 1932, and the two other intermediate States report a 10% reduction in commercial acreage.

Total shipments of old potatoes for the week of March 5–11 dropped to the low level of about 3,900 cars, but movement subsequently increased to around 6,000 cars per week, and by the latter part of March the output was exceeding that of a year ago. F. o. b.

prices reached a relatively high level during the period of restricted movement and then lost part of their gain. But the general price situation at shipping points and in city markets showed considerable firmness and strength during the closing days of the month.—BUREAU OF AGRICULTURAL ECONOMICS, U. S. D. A.

SECTIONAL NOTES

CONNECTICUT

Magnesia Fertilization of Potatoes

It has been discovered recently that on some farms in Aroostook County, Maine, a deficiency of available magnesia was responsible for marked reductions in the yields of potatoes. Where such conditions occurred, normal growth and yields have been obtained by supplementing the ordinary fertilizer with a material carrying about 20 pounds per acre of soluble magnesia.

In Connecticut many inquiries concerning the advisability of using a carrier of magnesia on the potato crop in that state were received by the Agricultural College. Having no data on which to base an opinion, the Agronomy Department started six tests last spring in eastern Connecticut. A rather wide range in soil conditions was obtained by locating one test on a potato farm in each of three counties and the other three on different soils on College property. For instance, the pH readings varied from 4.71 to 5.25, the lime requirement from 4300 to 5800 pounds per acre, and the organic matter content from 5.5 to 9.2 per cent.

In each case, ordinary fertilizer, containing no magnesia, was used at the usual rate. In addition, the treatments, listed below, were applied in the row before planting on triplicated, five-row plots, one hundred feet long: (1) No magnesia; (2) Magnesium sulphate at 100 pounds; (3) Magnesium sulphate at 200 pounds; (4) Dolomitic limestone (20% magnesium oxide) at 200 pounds; and (5) Dolomitic limestone (20% magnesium oxide) at 400 pounds. Aside from the application of carriers of magnesia, the potatoes were handled throughout the season in the regular manner.

Neither the vine growth nor the yields revealed any significant effects of the magnesia treatments. The average yields of all tests expressed as total bushels per acre were as follows: No magnesia—315; magnesium sulphate, either at 100 or 200 pounds—309; limestone at 200 pounds—314; and limestone at 400 pounds—318.

These results *indicate* that in Connecticut potatoes have not suffered from a lack of magnesia and it is not essential to include carriers of magnesia in potato fertilizers. However, tests should be conducted over a wider range of soil and weather conditions before drawing final conclusions. Regardless of the magnesia problem, it is probable that over a period of years yields of marketable potatoes on

strongly acid soils (below pH 5.0) will be increased by small and properly timed applications of lime. This point is particularly important where it is essential to increase the organic matter content of the soil by growing green manure crops.—B. A. BROWN.

NEW YORK

New York is divided into two potato sections in which conditions are very different. The Long Island section is small in area, but its level soil, free from stones and close to the greatest market in the world, has been found to produce Green Mountain potatoes of the very highest quality. Here profits from potato production have raised land values to a high point and forced the use of all available farming soil for potatoes, cauliflower or other high value vegetables. Large scale production by almost manufacturing methods have been thoroughly worked out by the Long Island growers. Cobblers are grown for late summer sale, Green Mountains for fall and winter.

The acreage in the larger up-state section is less than half that of twenty-five years ago. Most of the land is hilly, rough and stony. Before the war, hand labor was profitably used in the production of immense crops of potatoes. The increased cost of labor in proportion to the value of product, compared with pre-war conditions, has gone far to drive potato production from this section. In many counties also the relatively higher prices received for market milk in the large cities have forced former potato growers into dairying, a business better able to utilize rough and stony soils.

Growing too many varieties has badly damaged the reputation of up-state potatoes. The Smooth or White Rural is the most popular type grown, but Green Mountains, Irish Cobblers, Russet Rurals and Up-to-Dates are all grown in large quantities. As a result of the many varieties, carlot shippers find great difficulty in preventing varietal mixture in the carloads. This defect has been an outstanding cause of loss of markets. In desperation, shippers and growers recently secured the passage of a law establishing what was practically compulsory potato grading, only to find that a mixture of potato varieties is not made any more attractive to the consumer by a certificate stating they are "U. S. Number One, Round Whites."

Several conditions are now operating in favor of the potato growers of the up-state section. The first is that of certified seed production. The high quality of the certified seed produced by New York growers under the inspection service of the State College of Agriculture has resulted in such heavy demand from other producing sections that over half a million bushels is a normal annual production.

The second is that of the development of large scale production on the more level lands up-state. One interesting thing here is the increase in production on muckland soils from almost nothing a dozen years ago to 1,620,000 bushels on 5,400 acres in 1932. Just as the

progressive Long Island growers are among the heaviest users of certified seed, so the large up-state growers find it to their advantage to use the best labor saving machines, certified seed, the best marketing methods, and the latest information on disease and insect control.—DANIEL DEAN.

WASHINGTON

Owing to the delay of warm spring weather our plans for the 1933 acreage in Washington are still rather indefinite. Present indications lead one to predict an increase in requests for the certification of seed potatoes. There is also an indication that the increase will affect the early varieties more than the late or main crop varieties. Through the cooperative efforts of our certified seed potato growers with the Department of Agriculture and commercial growers, demonstration plots have been carried on in our principal potato districts for the last five years for the purpose of comparing the value of certified and non-certified seed. These demonstrations, together with some educational advertising on the part of the certified seed potato growers have very materially increased the demand for certified seed in Washington. We are also developing a market for some of the early varieties in California, which also adds to the interest in the production of certified seed potatoes.

About 95 per cent of the potatoes grown in the State of Washington are of the Netted Gem or Russet Burbank variety. The remainder is principally of the Irish Cobbler and Earliest of All varieties. The small acreage of early commercial potatoes is produced in the Pasco-Kennewick section and supplies only our local Washington market. The late potato crop is consumed mostly on the Pacific Coast, although when prices are sufficiently high, shipments into the mid-western cities are also common.—CHARLES D. GAINES.

MAINE

The "Government Intentions for Planting" report for March indicated a 15% reduction in acreage in Maine for the coming season, and the report for January indicated a 12% reduction. It seems to be the consensus of opinion among the more reliable and conservative growers that there will be at least an approximate reduction of 20% in acreage at planting time. Many well informed people in Aroostook have a strong feeling that the reduction will be even greater. It must be borne in mind, however, that a 20% reduction in acreage will not mean a 20% reduction in yield and that under favorable growing conditions, there will be a larger crop than would be expected in view of the reduction. There have been three favorable seasons for the development of Late Blight and in each year considerable reduction in yield was caused by the epidemic in localized areas.

Much depends, of course, on developments the next few weeks in the market for old potatoes and the amount of money the Government

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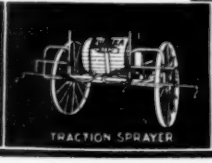

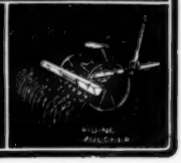

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will loan through the Regional Agricultural Credit Corporation. One of the best indications that the reduction in acreage will be at least as high as the Government estimate is due to the definite reductions demanded as a requisite for the granting of the loan applications. A large percentage of the growers in Aroostook depend upon financing from this agency.

The growers in Maine are much discouraged with the apparent prospects for another year, particularly in view of the fact that there has been two years now in which they have received abnormally low prices. All local credit sources are exhausted. With the outlook as it is, based upon the most reliable information available, no one is anticipating operations for the coming season with any degree of enthusiasm.

The most reliable judges seem to feel that Maine will ship approximately forty to forty-two thousand cars this year. Indications point toward a probable demand for all of the stock left at present prices on a somewhat higher price level. There is a firmer undertone to the market, even in face of the heavy shipment for the past three weeks. Another factor of importance is the excellent condition of the remaining supplies in storage. Probably never during the past ten years are the old potatoes keeping so uniformly well as they are this year. —FRANK W. HUSSEY.

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